International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 03 | Mar 2020 www.irjet.net p-ISSN: 2395-0072

Implementation of TPM Philosophy on Critical Paint Shop Machine

Devang Kachhadiya

Student, Dept. of Automobile Engineering, Indus University, Gujarat, India

---

Abstract – *In this paper, an idea, introduction and implementation approach of Total Productive Maintenance (TPM) is explained thoroughly. As its name suggests, TPM is a new concept and industrial quality tool which deals with the maintenance of important industrial machinery. This paper will define TPM's strengths as a maintenance philosophy, its implementation approach and difficulties in its implementation. The paper put together deals with the organizational structure required for TPM implementation and shows how the organization structure affects the results of TPM. The paper conjointly discusses the proper ingredients required for successful TPM implementation. TPM is to Maintenance pretty much as Total Quality is to Production. The purpose of the TPM is to markedly increase production whereas, at the same time, job satisfaction increasing workers' morale. The results of implementing the TPM in terms of increased plant potency and productivity are excellent. The report concludes that the implementation of TPM is not a simple task, which is significantly burdened by organizational, activity and other barriers, and necessitates the tough mission to alter peoples' mind-sets from a traditional maintenance approach.*

***Key Words*: Total Productive Maintenance, 8-Pillar of TPM, Implementation of TPM, Industrial maintenance tools, Overall Equipment Effectiveness (OEE),**

1. Introduction

Total Productive Maintenance (TPM) is the development of the lean manufacturing system. TPM builds a dense relationship between Maintenance and Productivity, The direct goal of TPM is zero breakdowns zero accidents and zero loss. If machine uptime is predictable, the industry can produce a velocity of sales. Morden companies require that the organizations that want to be successful and to achieve world-class manufacturing should have both effective and efficient maintenance. Therefore, one of the best approaches to achieve the higher performance of maintenance activity can be done with the help of total productive maintenance.

1.1 Objective of Total Productive Maintenance

The main objective of TPM is the constant improvement of equipment effectiveness with the help of the contribution of every individual as a team. Total quality management and total productive maintenance are reflected as the essential operating activities of the quality management system. For TPM to be effective, the full support of the labours and supervisors is required.

The main objective of Total productive maintenance is to improve the Overall Equipment Effectiveness of critical plant equipment. TPM addresses the conditions for accelerated deterioration while creating the suitable environment between operators and equipment to create ownership.

Overall Equipment Effectiveness
(OEE) = Performance x Availability x Quality

Here,
1) Availability =
(Planned production time-Unscheduled Downtime)/ Planned production time

Where, Production time = Planned production time – Downtime

2) Performance =
(Cycle time x No. of products processed)/Production time

3) Quality =
(No. of Products processed-No. of Products rejected)/ No. of Products processed

This Terms can also be understood by this Figure.

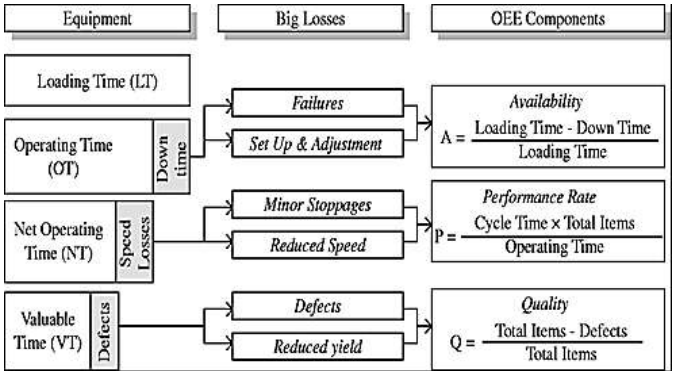

Fig -1: OEE Calculation Process

1.2 Goals of TPM

TPM is based on a "zero-loss" concept. The goal of the concept is to allow you to achieve high reliability and flexibility of equipment. It also helps to overcome cost problems by minimizing wastage of manpower, material, energy, and so forth. TPM is achieved through particular objectives,

Which are:

- Zero breakdowns
- Zero defects
- Zero accidents
- Minimum waste
- Aware and skilled labour to promote autonomous maintenance
- At least 90% 'Overall Equipment Efficiency'
- High productivity and efficiency

2. Total Productive Maintenance Pillars

5S is the first step of the TPM program. It is a systematic process to achieve a serene environment in the manufacturing plant. 5S is the base of the TPM. Toyota Motors was the first company which has implemented this concept. Nowadays, companies like Tata Motors, Ford, and Honda use this basic concept to maintain higher standards. The following are the pillars of 5S.

Sr. No.	Japanese terms	Equivalent 'S' English terms
1	Seiri	Sort
2	Seiton	Systematize
3	Seiso	Sweep
4	Seiketsu	Standardize
5	Shitsuke	Self-discipline

Table -1: 5S

The concept of TPM is based on 8 pillars or elements of TPM.

1. Autonomous Maintenance (Jishu Hozen)
2. Focused Improvement (Kobetsu Kaizen)
3. Planned Maintenance
4. Quality Maintenance
5. Early Management
6. Education and Training
7. Office TPM
8. Safety, Health, and Environment

2.1 Pillar 1:- Autonomous Maintenance (Jishu-Hozen)

This pillar mainly focuses on uninterrupted operation, flexible operators and daily maintenance. General inspection and daily cleaning are the main elements of Jishu Hozen. There are several steps or activities in inspection like check lubrication, cleaning, tightening of loosened bolts, etc.

To implement Autonomous maintenance these steps must be followed:-

1. Preparation of employees
2. Initial cleaning of equipment
3. Take countermeasures
4. Fix tentative Jishu Hozen standards
5. General inspection
6. Autonomous Inspection
7. Standardization

2.2 Pillar 2:- Focused Improvement (Kobetsu Kaizen)

Focused improvement is also known as Kobetsu 'Kaizen' in which 'Kai-'means change and '-Zen' means 'Good'. This pillar is for small but necessary improvement which will contribute to the overall equipment effectiveness of the equipment because very large numbers of small improvements can result in a more effective as well as an efficient organizational environment. The main goal is to achieve and sustain zero losses, cost reduction, improve overall plant equipment effectiveness and to reduce minor stops on the assembly line.

2.3 Pillar 3:- Planned Maintenance

The main target of planned maintenance is to have continuous operations of machine and equipment to produce quality products with total customer satisfaction, in short, Zero losses, better machine reliability and maintainability, low maintenance cost and availability of spare parts. The planned maintenance divides into four types.

1. Breakdown Maintenance
2. Preventive Maintenance
3. Corrective Maintenance
4. Maintenance prevention

There are six steps in planned maintenance:-

1. Equipment evaluation and recoding current status
2. Restore condition and eliminate weakness
3. Building up the information management system
4. Prepare time-based data system then select equipment, parts, and members and make a plan
5. Establish predictive maintenance system
6. Evaluation of planned maintenance

2.4 Pillar 4:- Quality Maintenance

To implementing this pillar industry should be focused on zero defects, zero customer complaints and low cost of quality. Through quality maintenance, we gain an understanding of which part of the machine is responsible for a defect in product quality and begin to eliminate existing quality problems then move to potential quality problems.

2.5 Pillar 5:- Early Management

This pillar usually implemented after the successful implementation of the first four pillars. The main goal of early management pillar is to reduce and optimize equipment downtime and cost of maintenance and reduce

development lead time so equipment start can be achieved with zero quality losses.

2.6 Pillar 6:- Education and Training

This pillar one of the most important pillars because it is focused on the morale and skill of workers and employees. The main aim of this pillar is to educate and train workers according to machines because every worker should know operation TPM. It is not enough that they 'Know-How' but they also have to learn 'Know-why'. It is the responsibility of the TPM officer to train workers to some level so they can also train other workers in the industrial area. After the training worker should be able to understand elements of TPM and able to take action on their own. This will help the industry to minimize the losses.

2.7 Pillar 7:- Office TPM

Office TPM should be taken under consideration after the implementation of the first four pillars. Office TPM helps to improve productivity, efficiency in administrative areas and identify and eliminate losses. This should be implemented by senior person e.g. Head of Finance, General Managers, etc. He should be responsible for providing awareness about Office TPM to all the departments. The goal of Office TPM to improve the accuracy of data collection, better-utilized work area, reduction in unnecessary data files, reduction in customer complaints and higher customer satisfaction.

2.8 Pillar 8:- Safety, Health, and Environment

The main target of this pillar is

1. Zero accident
2. Zero health damage
3. Zero fires

In this area, Focus is on creating a safe and healthy environment around the company premise to achieve zero safety goals. According to this pillar, every company should form a separate department for safety and it should be able as quickly as possible to prevent any fatal injuries. For safety awareness, Slogans, posters, drama, etc. can be organized at regular intervals.

3. Implementation of Total Product maintenance

Implementation of the TPM program is not a 4 or 5 months program, it can go on for a very long time till necessary results occurred.

There are 12 steps for implementation of TPM:-

1. Announcement of implementing TPM: - Top management needs to create the necessary environment to introduce the TPM.
2. TPM introductory program and training: - This program will educate everyone about TPM activities, benefits and objectives in the organization.
3. Establish an organizational structure: -This will encourage communication between workers and management to the next level so it will be ensured that everyone is working towards the same goal.
4. Formulate basic TPM policies and Targets: - According to the current condition of the industry, Specific and Suitable policies will take effect and targets will be set.
5. The master plan for TPM deployment and presentation: - After the implementation of step 4 this step will take effect. Necessary resources and manpower will be identified and customized implementation strategy and precaution will be considered.
6. Feasibility study and its presentation: - All successful TPM installation has been led by exceptional feasibility research. During this period data collection like OEE data collection will be done. If it is lower than the target, there will be a meeting to improvise. This step can also be considered as TPM-kick off.
7. Plot Installation: - A TPM pilot installation should cover a few selected machines for TPM. Appropriate areas for pilot installation are where major improvement is needed or on critical equipment.
8. Plant-wide installation: - After a few months of pilot installation companies should expand their TPM installation all over the plant. Expansion initiatives should be repeated every 3 to 6 months with the same targets and criteria as pilots.
9. Introduction Audit: - Audit is a very important part of this process. It is needed to check and ensure good progress and successful installation. They are normally carried out 6-12 months after lunch by specialists.
10. Progress audit: - It is the last step before the certification step. This step is important because it will point out existing opportunities and deficiencies. In this step, Preventive maintenance, Documentation, OEE data, planning, etc. should be ensured.
11. Certification: - This step will show that the organization has achieved a standard level of TPM. The International TPM certification process has a strict set of requirements.
12. TPM Award: - The final and rewarding step of this process is the TPM Award. This award shows that organizations have world-class manufacturing standards, high productivity, and top quality and has a culture of team-work.

4. Result analysis of Implementation of Total Product maintenance at TATA Motors Ltd. Sanand

This project was undertaken at TATA Motors Ltd, at Sanand. TATA Motors Ltd. is one of the giant Indian Automobile Manufacturer. TPM has been implemented on all critical machines at the paint shop of TATA motors. These critical machines play a very important role in the manufacturing of

automobiles. So the company cannot risk the unexpected breakdown of these machines and equipment.

These are equipment under TPM: -

Equipment under TPM		
Sr. No.	**Area**	**Equipment**
1	Colour Selection area	RB132,134,136 & Transfer Car
2	Sanding Exit LT & TC	LT34,36,38,40 & RB 30 & 24
3	Sanding Exit Elevator	EL44
4	PT Entry LT (RO- DIP)	RB:80,CC01,RB:121 & LT121
5	WBS Locking Station	RB46,48 TT;RRBB1,TT,RB2
6	Sealer Entry	LT98,RB96,RB94,,TT92, BT100
7	Paint Kitchen	
8	Rectifier	
9	Sealant Kitchen	
10	Base Coat ROBOT	RB,11,12,21,22
11	TC Booth	BC Exhaust
12	TC Booth	Primer Exhaust
13	Paint Shop	Workdesk ASU:1
14	Paint Shop	Workdesk ASU:2
15	TC Booth	Booth :1 ASU :1
16	TC Booth	Booth :1 ASU :2
17	Paint Shop	Shop Ventilation ASU: 1
18	Paint Shop	Shop Ventilation ASU: 2

Table -2: Equipment under TPM

This is an analysis of the TPM of critical machines at the Paint shop of TATA motors.

4.1 5S Implementation

In 5S implementation workers follow simple and basic rules of 5S e.g. sorting, cleaning, set in order, standardizing and self-discipline.
Here is 5S BEFORE-AFTER implementation scenarios of some critical and important machines of the Paint shop.

Here on the left-hand side picture is shows 'Before' and right- hand side picture shows 'After'.

Fig -2: Tag replacement on the Control desk

Fig -3: Tag replacement on the Control desk

Fig -4: Cleaning of Conveyer and floor around it.

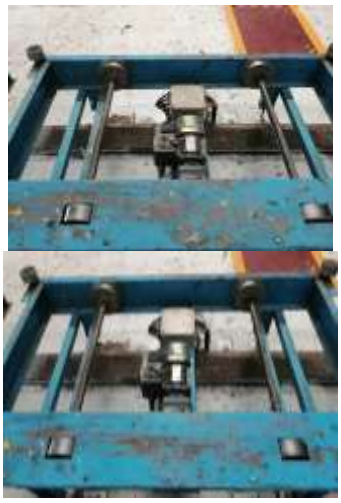

Fig -5: Cleaning of Roller bed

Fig -6: Roller bed Tag replacement at WBS

Fig -7: Safety line around Turning Table for safety

Fig -8: Control area Map is placed on CD at sealer area

Fig -9: Control area Map is placed on CD at sanding line exit

4.2 Calculation of OEE

These calculations show data form one of the equipments of equipment under TPM of paint shop of TATA motors.

Before TPM Implementation		
A	Shift Time (General)	480
B	Planned brakes	50
C	Planned Production Time (A-B)	430
D	Downtime	80
E	Production Time (C-D)	350
F	Availability (E/C)x 100	81.39%
G	Ideal cycle time(min)	300
H	Efficiency (Gx 100)/E	85.71%
I	Output	200
J	Rejection	18
K	Quality (I-K x 100)/I	91.5%
OEE= Availability x Performance Efficiency x Quality Rate 81.39% x 85.71% x 91.5% 63.82%		

Table -3: OEE before TPM implementation

For OEE in May,

In TATA motors, Paint shop machines are scheduled to run for 8 hours (480 min) and had two shifts. Cycle time: 90 seconds.

The paint shop has two small breaks each of 10 minutes and one lunch break of 30 minutes, thereby experiences 50 min of total planned downtime.

Unplanned downtime is breakdowns = 10 minutes, Equipment failure & inspection time = 30 minutes, Non- scheduled breaks = 10 min.

Planned Production Time = Shift Length – All Breaks

= 480 min- 50 min

= 430 min

Production time = Planned production time –Downtime

= 430 minutes – 50 min

= 380 min

Availability: = (380/430) x 100

= 88.37 %

Ideal cycle time = 230 total parts x 90 seconds

= 20700/60 = 345 minutes

Performance = (345/380) x 100

= 90.78 %

Good Count = Total Count (output) – Reject Count

= 230 - 10 parts = 220 parts

Quality = (220/230) x 100

= 95.65 %

Overall equipment effectiveness = 88.37 x 90.78 x 95.65

OEE = 76.73 % = **77 %** in May

After TPM Implementation		
A	Shift Time (General)	480
B	Planned brakes	50
C	Planned Production Time (A-B)	430
D	Downtime	50
E	Production Time (C-D)	380
F	Availability (E/C)x 100	88.37 %
G	Ideal cycle time(min)	345
H	Efficiency (Gx 100)/E	90.78%
I	Output	230
J	Rejection	10
K	Quality (I-K x 100)/I	95.65%
OEE= Availability x Performance Efficiency x Quality Rate 88.37% x 90.78% x 95.65% 76.73% = 77%		

Table -4: OEE after TPM Implementation

OEE of paint shop is increasing day by day due to the implementation of TPM activities which is the result of reduced maintenance cost of equipment and a decrease in the trend of red and white tags.

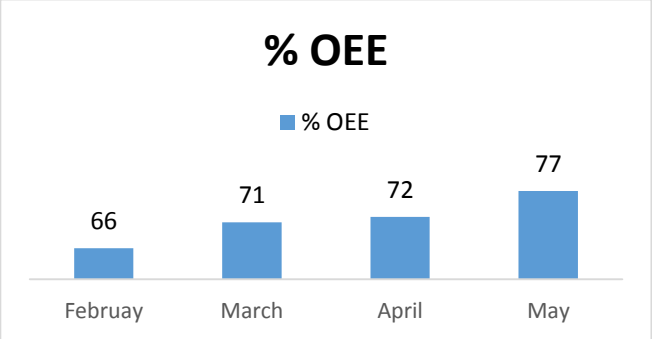

Chart -1: %OEE

Nowadays, Operators can fix the equipment on their own because of the proper training and implementation of TPM in the Paint shop.

Due to the impact of TPM OEE of paint shop stabilize and increasing throughout year as well as the reduction in red and white tags and breakdown and breakdown time which is shown in charts.

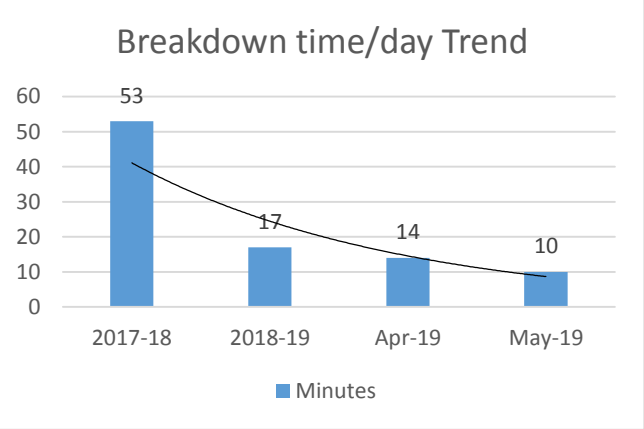

Chart -2: Breakdown time per day

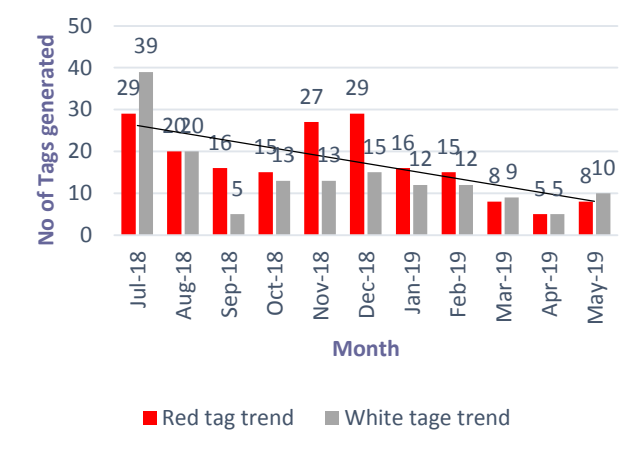

Chart -3: Red and white tags trend 2018-19

5. Conclusions

I have concluded that by the implementation of TPM, OEE can be increased which is the result of less breakdown and breakdown maintenance time, Safety standards are increased, less or no accident occurred as well as the trend of the white and red tag is reduced significantly. TPM is a very beneficial tool for any industry. TPM program increases the reliability and performance of the machine and the quality of the product. Nowadays, TPM is a thing that can play a crucial role in industries' success. It has been confirmed to a program that works. It is not only suitable for industrial plants but a variety of other situations. Employees must be refined and convinced that TPM is not just another "Program of the month" and that management is dedicated to the program and the extended time frame essential for full implementation. If every worker participates and contributes, higher goals may be very easy to achieve and more profit will be generated.

REFERENCES

[1] Schonberger, R.J., 1986. World Class Manufacturing: The Lessons of Simplicity Applied. The Free Press, New York.

[2] Schonberger, R.G., 1993, „Operation Management, Decision making in the Operations Function" 4th edn. McGraw-Hill, New York.

[3] SEMI (2003). SEMI E124: Provisional Guide for Definition and Calculation of Overall Factory Efficiency (OFE) and Other Associated Factory-Level-Productivity Metrics.

[4] San Jose, SEMI. Society of Manufacturing Engineering (1995), Total Productive Maintenance in America. Dearborn, MI, Society of Manufacturing Engineer.

[5] Leflar, J. (1999), "TPM at Hewlett-Packard. 10thTotal Productive Maintenance Conference." Las Vegas, NV, Productivity, Inc.

[6] Leflar, J. (2000), „Achieving Precision Maintenance." 11th Total Productive Maintenance Conference and Exposition." Dallas, TX, Productivity, Inc.

[7] Marsh, H.W., Hocevar, D., 1985 „ Application of confirmatory factor analysis to the study of self-concept: first and higher-order factor models and their invariance across groups" Psychological Bulletin 97, 562-585.

[8] Maci, 1995. „Four phase approach to planned maintenance" In: Proceeding of the Sixth Annual Total Productive Maintenance conference and Exposition. Productivity Inc., Norwalk, vol. 22. Norwalk, CT, pp. 204-243.

[9] Ahuja, I.P.S and Kamba, J.S. (2008a), "An evaluation of TPM initiatives in Indian industry for enhanced manufacturing performance," Journal of Quality in Maintenance Engineering, vol.13 no.4, pp.338-52.